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COMPARISON OF FOUR METHODOLOGIES TO PROJECT EMISSIONS FOR THE ST. LOUIS METROPOLITAN AREA

T. J. Consroe

Booz-Allen and Hamilton, Incorporated

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- Summarize the structure and nature of each projection methodology
- Compare the numerical projection results
- Discuss the relative advantages of each methodology.

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by

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Contract No. 68-02-1005

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Prepared for

ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
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I. INTRODUCTION

This report presents a comparison of four alternate methodologies which were used to project air pollution emissions for the metropolitan St. Louis area. Two of the four methodologies also forecast expected ambient air quality levels. The purpose of the study was to:

- Summarize the structure and nature of each projection methodology
- Compare the numerical projection results
- Discuss the relative advantages of each methodology.

Two of the four projection methodologies were developed as general purpose emission projection models which may be applied to other geographic areas. These models are:

- The Regional Emission Projection System (REPS).* This system is an operational computer program which is an element of the EPA's Aerometric and Emissions Reporting System (AEROS).
- The Plan Revision Management System (PRMS). This system includes two elements:
  - Guidelines for developing projections of emissions and air quality for a given AQCR which can be expected from enforcement of SIP regulations.†
  - A computer analysis of these projections and pollutant concentration monitoring data to

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* Booz, Allen and Hamilton Inc., The Regional Emission Projection System, Summary Report, February 1975.

† Research Triangle Institute, Manual for Analysis of State Implementation Plan Progress, March 1974

determine if adequate progress toward meeting the objectives of the SIP is being made.*

The methodology contained in the guidelines for projecting emissions as applied to the St. Louis AQCR, was analysed in this study.

The other two projection techniques were developed as elements of specific studies of air pollution in St. Louis. These two studies are:

- Attainment of National Air Quality Standards for Carbon Monoxide and Oxidants in the St. Louis AQCR.† Emissions and air quality were projected in this study to determine whether national ambient air quality standards would be attained after implementation of various proposed emission control strategies. This methodology is referred to in this report as the "Attainment Study."

- St. Louis Trial Air Quality Maintenance Plan.‡ The development of the trial AQMP also involved projecting emissions and air quality. This methodology is referred to in this report as the "Trial AQMP."

Comparison of these four methodologies is not a straightforward task for a number of reasons. As mentioned previously, REPS and PRMS are general purpose models, while the Attainment Study and the Trial AQMP were specialized studies for St. Louis. Thus, the structure of the latter two methodologies was oriented specifically to the mix of source categories and other factors unique to St. Louis. The direct comparability of numerical results is further complicated because each study did not consider the same:

- Pollutants: A minimum of two and a maximum of five pollutants were considered.

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* U.S. Environmental Protection Agency, The Plan Revision Management System, Summary Report (draft), October 1974.

† PEDCo - Environmental Specialists, Inc., March 1974.

‡ Planning Environment International, December 1974.

- Geographic area: One study included the St. Louis Air Quality Maintenance Area (AQMA), the others the St. Louis Interstate Air Quality Control Region (AQCR). The St. Louis AQMA is a subregion of the St. Louis AQCR.

- Base year for which a local emission inventory was established.

- Projection years for which forecasts were developed.

In addition, the input data from which emission inventories, growth factors and the effect of control regulations were developed were not identical for all four studies. The preceding factors should be considered when using the numerical comparison as a basis for comparing the actual projection methodologies. The key features of each methodology are summarized in Figure 1.

The remainder of this report contains the following sections:

- A summary of each projection methodology, including identification of data sources consulted and inherent assumptions

- A comparison and interpretation of the numerical projection results.

FIGURE 1
Key Features of the
Projection Methodologies

Feature	Projection Methodology: REPS	PRMS	The Attainment Study	Trial AQMP
Geographic Region	Any AQCR or the nation	Any geographic region	St. Louis AQCR	St. Louis AQMA
Pollutants Considered	HC CO TSP SO_x NO_x	HC CO TSP SO_x	HC CO	HC CO TSP SO_x
Base Year	1974*	1970†	1972	Various years adjusted to 1975
Projection Years	1980*	Continuous to 1977 in semi-annual increments†	1975 1977 1980	1980 1985
Emission Projections	Yes	Yes	Yes	Yes
Air Quality Projections	No	No (procedures given but not numerical results)	Yes	Yes
Publication Date of Reference Report	May 1975	March 1974	March 1974	December 1974

* Base year and projection year for REPS are the option of the system user. The base year may be 1974 or any subsequent year; projections may be developed for any year between the base year and 2000.

† The PRMS methodology may be applied to any base year and projection period.

II. SUMMARY OF PROJECTION METHODOLOGIES

1. THE REGIONAL EMISSION PROJECTION SYSTEM (REPS)

The Regional Emission Projection System is a computerized air pollution emissions projection model, for use at the AQCR level, to project annual emissions. It combines exogenous national and regional economic forecasts with point and area source emission inventories for Air Quality Control Regions (AQCRs) to project air pollution emissions levels for all five criteria pollutants on an annual basis. REPS can be used to project emissions for any of 243 Air Quality Control Regions (AQCRs) and for the nation as a whole.* The base year to which all growth is referenced is 1974 or any subsequent year, and projections may be made for any year between the base year and the year 2000. At the present time REPS does not have the capability to produce projections of air quality.

The projection methodology involves the following major steps:

- Determine regional growth factors for future years which reflect the expected change (positive or negative) in pollution-producing activity. Growth factors are determined from regional economic and demographic forecasts.

- Project present regional emission inventories to future years using these growth factors. The base year emission inventories are those of the National Emissions Data System (NEDS).

- Adjust the emission projections to include the effects of present and future control regulations. These include existing regulations from NEDS, and promulgated Federal standards (incorporated automatically by REPS) and state or local regulations (supplied by the user).

The methodology is described in more detail below.

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* REPS does not consider the four AQCRs which include U.S. territories because regional economic projections were not available for them.

There are two primary sources for the economic and demographic forecast data used in REPS: EPA developed national economic growth projections, and Department of Commerce regional activity projections. National economic growth projections are taken from a standard output of the SEAS system,* and include total gross output for each of 284 economic sectors and subsectors. For each region, the relative share of the SEAS national output forecasts is established using the OBERS economic projections† for AQCRs, which contain regional forecasts of population and employment, in addition to projections of regional earnings for 28 industrial sectors. Since 55 of the SEAS economic sectors produce air pollution, combining the SEAS and OBERS projections produces 55 different industrial growth factors. Four demographic and commercial growth factors are computed from OBERS data above, resulting in a total of 59 different REPS growth factors.

The SEAS and OBERS projections have been supplemented in REPS by a special analysis of growth and relocation trends for five industries which are among the heaviest industrial polluters. These critical industries are electric power generation, steel, chemicals, pulp manufacturing and petroleum refining. The output of this analysis is a file of data on new plants expected to become operational in the future. For each plant, the SCC code, the AQCR, the projected startup year and the plant capacity are given. These data may be input to the program at the user's option.

In REPS emissions are projected on an individual source basis by applying these growth factors to base year emissions as reported by NEDS, and adjusting the projections to include the effect of emission controls required for each source in the projection year. The specific method for projecting emissions depends on the emission source category:

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* Strategic Environmental Assessment System, an econometric and emission forecasting model developed by the Office of Research and Development, Environmental Protection Agency, Washington, D.C.

† Regional Economic Activity in the U.S., 1972 OBERS Projections, developed by the U.S. Departments of Commerce and Agriculture for the U.S. Water Resources Council.

- Industrial process. Base year emissions for each point source are first converted to uncontrolled emissions using the base year control efficiencies given in NEDS. Growth factors for each process category (such as primary metals, petroleum refining, etc.) are applied to project future uncontrolled emissions, which are then reduced to comply with control regulations for the projection year.

- Fuel combustion. Base year emissions for each point source are converted to fuel use and Btu demand. Growth factors for each customer category are used to project the Btu demand for each category. The projected Btu demand is then apportioned to the fuels expected to be used for that customer category in the projection year. This approach produces growth factors for each fuel within each customer category. These growth factors are applied to emissions for each point source, and projected emissions are reduced to comply with control regulations.

- Solid waste disposal. This category is treated in the same way as fuel combustion, except that the amount of solid waste burned, rather than the Btu demand, is determined for each customer category in the base year and projection year, and the projected tonnage is allocated to disposal methods in the same way that future fuel mix is used to allocate the projected Btu demand.

The REPS system includes the effect of control regulations in two ways. First, if any point source has been granted a control variance which will have expired by the projection year, projected emissions are reduced to the level allowable under those regulations. Data concerning current regulations are taken from the NEDS point source inventory. Second, Federal New Source Performance Standards which govern new and retrofit industrial equipment are included in the REPS system. At the user's option, standards already promulgated in the Federal Register are input, as well as proposed standards which are likely to be promulgated in the future. The proposed standards were supplied by the Emission Standards and Engineering Division of the EPA's Office of Air Quality Planning and Standards. The effect of New Source Performance Standards on future emissions is determined in the REPS system by estimating the portion of projected activity which will involve equipment or facilities governed by these standards.

The procedure for projecting area source emissions is to compute future area source emissions for each record in the NEDS area source inventory for the AQCR. One NEDS area source data record ordinarily contains a summary of source activity for a given county or similar jurisdiction.

In general, future area source fuel combustion is estimated by projecting the Btu demand for each customer category and allocating that demand to the fuel mix for the projection year. Future levels of area source solid waste disposal are estimated by projecting the future level of solid waste disposal for each customer category, and distributing that amount among the various methods of disposal. This method is similar to the procedure used to project point source fuel combustion and solid waste disposal described previously. Transportation emissions are projected by applying a different growth factor to each of the following transportation categories:

- Highway vehicles
- Off-highway vehicles (diesel)
- Off-highway vehicles (gasoline)
- Rail locomotives
- Vessels (recreational)
- Vessels (commercial)
- Aircraft (civil and commercial)
- Aircraft (military).

The REPS system does not include emission controls for any area source category except gasoline highway vehicles. Regulations affecting emissions from these vehicles will have the ultimate effect of lowering the emission factors (emissions per mile travelled) appropriate for future years. REPS computes weighted highway vehicle emission factors which reflect these regulations. These weighted emission factors are a function of:

- The nationwide average vehicle age distribution
- Nationwide average travel for vehicles of each age group
- Speed correction factors corresponding to vehicle-mile data from NEDS
- Test emission factors for a given model year and vehicle age.

The method for computing weighted emission factors, as well as data of the first three types given above, is given in AP-42. The test emission factors were taken from AP-42, Supplement Number 5 (draft), and include inherently the effect of deterioration of control devices.

2. THE PLAN REVISION MANAGEMENT SYSTEM (PRMS)

This system was designed to monitor progress of an AQCR in satisfying the requirements of an SIP. The system considers TSP, CO, SO_x and HC pollution, and includes two elements:

- Guidelines for developing projections of emissions and air quality for a given AQCR which can be expected from enforcement of SIP regulations

- A computer analysis of these projections, together with air quality monitoring data, to determine if adequate progress toward meeting the objectives of the SIP is being made.

The guidelines for projecting emissions and air quality specify three types of input data for the AQCR under study:

- Air quality data (SAROAD)
- Emissions data (NEDS)
- Enforcement and compliance information (CDS).

From this information, a projected air quality curve may be developed for the AQCR. As additional ambient air quality data are submitted, they will be entered into the SAROAD system. PRMS will analyze these data by comparing them to the projected air quality values to determine if adequate progress has been made. In each case where measured levels exceed projected levels, (allowing for statistical variation), the region will be identified as having a "potential deficiency." Since many factors influence air quality measurements, it is not possible to state conclusively that a deficiency resulted from an inadequate SIP. Therefore, after a deficiency is identified, a review should follow to assure that the deficiency was not the result of invalid air quality data or unusual meteorological conditions. Thus PRMS will identify "potential deficiencies" at monitoring sites within the AQCR and will indicate the need for further review.

Guidelines for developing the air quality projections which are input to the PRMS computer program are contained in the Manual for Analysis of State Implementation Plan Progress. This report contains specific instructions for the manual calculation of projected emissions and projected air quality for the four pollutants mentioned previously (TSP, CO, SO_x and HC). Two parallel procedures are given for developing these projections: a detailed (quantitative) method and a simplified (qualitative) method. The quantitative metnodology given in the manual has been analyzed for this project.

The quantitative method in general involves projecting emissions for a selected number of point sources on an individual source basis, and for the remaining point sources and all area sources on an aggregated source basis. The base year used for the St. Louis AQCR was 1970; projections were made in semi-annual increments to 1977.

The general projection method used for point sources for each of the four pollutants considered was as follows:

- Identify the individual point sources which account for 90% of the point source emissions.
- Project emissions for each of these sources using:
  - Allowable emissions and compliance dates for the point source from NEDS
  - Applicable local emission regulations
  - A growth factor for the emission source category in which the source is included.
- Project emissions for the remaining sources by aggregating emissions for each source category and applying the appropriate growth factor for that category. Projected emissions for SO_x and HC calculated in this manner were reduced to reflect emission controls as follows:
  - SO_x: same percent reduction as used for the individually calculated point sources
  - HC: reduce emissions by 40%.

  No reduction was applied to CO and TSP emissions.

The rank order listings of pollutants for the St. Louis AQCR were used to determine what specific sources are covered in the sources accounting for 90 percent of the point source emissions, the level to which calculations were made for St. Louis. For particulate matter the sources so identified included fuel combustion, primary metals, and mineral products; for SO_x: fuel combustion, primary metals, mineral products, and petroleum processing; for hydrocarbons: fuel combustion, chemical manufacturing, petroleum processing, surface coating, and petroleum storage; for carbon monoxide: fuel combustion, chemical manufacturing, and petroleum processing. Based on an analysis of the composition and distribution of the point sources accounting for 90 percent of the hydrocarbon emissions, and the proportion of hydrocarbon emissions contributed by point sources (less than 25 percent of total HC emissions), it was determined that the calculations could be reduced to the 80 percent group without significant reduction in precision. Performing individual source calculations for only the major sources in this manner simplified the projections considerably, since 154 of 1,048 point sources accounted for 90% of the TSP, SO_x and CO emissions, and 80% of the HC emissions.

The projection method used for area sources was as follows:

- Aggregate emissions for each area source category from all jurisdictions in the AQCR.

- Identify applicable local regulations which will effectively reduce projected area source emissions. The regulations which were used in the emission projections affected the following source categories and pollutants:

  - Coal combustion: TSP, SO_x

  - On-site incineration and open burning: all pollutants

  - Land vehicles (1976 compliance to Federal standards): all pollutants.

- Apply appropriate growth factors and control regulations to the geographically-aggregated area source emissions to estimate future emissions.

Growth factors were calculated for each major category of point and area sources. The source categories were:

- Fuel combustion — residential
- Fuel combustion — power plants
- Fuel combustion — other
- Industrial process
- Solid waste disposal — residential
- Solid waste disposal — other
- Transportation — land vehicles
- Transportation — other
- Miscellaneous.

The source of this information was the OBERS projections with two exceptions. The growth factor for power plants was developed from published FPC data on new plants or modifications to existing plants. The other exception was land vehicle transportation where growth was included in adjusted transportation emission reduction curves from the Federal Motor Vehicle Emission Control Program (FMVCP).

The industrial process growth factor was computed by first determining the growth factors for the primary industries in the AQCR: fluid crackers, stone quarries, mineral products, primary metal, process fuel, chemical manufacturing, and food and agriculture. A composite growth factor for all industrial processes was then determined by weighting these growth factors by the number of plants in each growth category. This composite growth factor was then applied to all industrial processes within the St. Louis AQCR.

Growth factors were calculated for each half-year period between 1970 and 1975 by determining a five year growth factor from the OBERS projections for those years. These growth percentages are applied in equal increments over the five-year period from the second half of 1970 through the first half of 1975. It was assumed that through the use of the new source review procedures there will be no increase in emissions or air quality beyond the scheduled attainment date. The rationale for this assumption is that if emissions from a new source are determined to cause a violation of the national standards, then the construction of that source would be prohibited and the air quality would remain within the national standards.

The PRMS documentation recommends using a proportional model to relate projected air quality to projected emissions. However, no numerical air quality projections were included in the PRMS references consulted for this study.

3. THE ATTAINMENT STUDY

The purpose of the Attainment Study was to determine whether national air ambient quality standards for carbon monoxide and photo-chemical oxidants would be attained in the St. Louis AQCR in the near future following implementation of various control strategies. The approach followed in this project involved:

- Establishing and gridding an emission inventory for the base year (1972) for the AQCR.
- Projecting the base year emission inventory to future years based on expected regional growth. Projection years of 1975, 1977 and 1980 were selected.
- Developing a set of feasible control strategies.
- Predicting pollutant concentrations for proposed strategies based on the projected emission inventory.

This approach is described in more detail below.

For the purpose of developing the base year emission inventory, sources were divided into four major categories. These were point sources (except power plants), power plants, gasoline highway vehicles, and non-automotive area sources (including diesel vehicles, non-highway mobile sources and stationary area sources). Since existing emission data were considered to be current and accurate for 1972, that year was taken as the base year upon which the emission projections were based. The sources consulted for data to establish the base year inventory and to develop the emission projections are discussed below for each of these source categories.

(1) Gasoline Highway Vehicles

This category includes light and heavy duty gasoline powered vehicles. Emissions from heavy duty diesel powered vehicles were included in non-automotive area source emissions, since they comprised only 0.3 percent of the total motor vehicles in the Missouri portion of the St. Louis AQCR. This proportion was estimated to be valid for the entire AQCR.

The calculation method used to determine emissions from gasoline highway vehicles is outlined in AP-42. For this method emissions are calculated from weighted emission factors and annual vehicle miles traveled, both of which are time dependent. Weighted emission factors were computed from:

- The vehicle age distribution
- Average travel for vehicles of each age group
- Vehicle miles traveled as a function of average speed
- Low mileage test emission factors
- Speed correction factors
- Average deterioration factors.

The midyear age distribution of motor vehicles in the St. Louis AQCR was obtained from automobile and truck registrations in the Missouri portion of the St. Louis AQCR. Region-wide registrations were assumed to be the same. Local registration figures were used because they represent the actual vehicle age distribution more accurately than do nationwide figures. The St. Louis vehicle age distribution showed a significantly newer car population than the national average. The newer the car population, the greater the number of controlled vehicles, and hence the lower the emissions. Nationwide averages for the annual distance driven by vehicles of a given age were used because no local data were available. The emission factors used in calculating the automotive emissions reflected the relaxed 1975 standards, promulgated by the EPA Administrator on April 11, 1973.

The 1972 average daily vehicle-miles traveled by road function (interstate, principal artery, etc.) were taken from county travel tables and related information provided by the Missouri State Highway Department and the Illinois Department of Transportation. The average daily distance traveled in subsequent years was calculated from growth rates taken from transportation forecasts published in 1972 by the Illinois Department of Transportation and the East-West Gateway Coordinating Council. The annual growth rates were calculated on the assumption that

1972-1980 growth will occur at a steady rate. Annual travel figures were calculated by multiplying daily travel by 365.

In general, CO and HC emissions decrease as vehicle speed increases. Average vehicle speeds by road function were obtained from a 1970 highway network survey. These data included average vehicle speeds for each of six road functions for each county in the AQCR. Low mileage test emission factors were taken from AP-42 (April 1973 edition). Factors reflecting relaxed 1975 standards supplied by EPA were substituted for the 1975 factors published in AP-42. National average deterioration factors and speed correction factors appropriate for the average speeds of road types in the AQCR were also taken from AP-42.

(2) Non-Automotive Area Sources

Non-automotive area source emissions for the base year were the sum of all the area source emissions reported by NEDS, except for light- and heavy-duty gasoline vehicles. The NEDS printout that was used listed emissions (area and point) by jurisdiction in the St. Louis AQCR, with emissions as of August 28, 1973. The area source emissions reported in NEDS were emissions calculated to exist under 1973 state and local regulations. The non-automotive area source emission categories were residential and commercial/institutional heating, area source solid waste disposal by combustion, off-highway gasoline usage, all diesel usage, aircraft, vessels, and gasoline marketing and solvent evaporation from architectural painting and dry cleaning.

The emissions from these sources were calculated by obtaining the total area source emissions from the NEDS printout and subtracting from that total, the emissions (also from the NEDS printout) of light- and heavy-duty gasoline-powered vehicles. Non-automotive area source emissions were calculated for 1975, 1977 and 1980 by assuming the changes in emissions were equal to relative changes in population. For the St. Louis AQCR, the population growth rate, from 1967 through 1980, is 1.3 percent per year.

(3) Power Plants

The 1972 emissions from steam-electric utilities in the St. Louis AQCR were obtained from NEDS. In calculating emissions for subsequent years, Union Electric Company predicted a growth rate of 7 percent per year for their facilities. Illinois Power Company estimated their annual growth rate at 10 percent. The growth rate of other (i.e., relatively small) utilities was assumed to equal the growth rate of miscellaneous manufacturing as reported by OBERS.

Percent increases in emissions were assumed to equal the growth rate percentage for electricity generation since no nuclear power facilities are planned for the region before 1980.

(4) Point Sources (Except Power Plants)

These sources were divided into two categories. Major sources were those which emitted more than one hundred tons per year in 1972. Three other point sources which emitted less than 100 tons per year were included nonetheless, since they were initially identified as major sources. Minor sources were those which emitted less than 100 tons per year. These sources were not individually identified and were treated as one aggregate source.

. Major non-utility stationary sources. The primary source of 1972 emission data for the major non-utility stationary sources in Missouri was the NEDS data bank for the St. Louis AQCR, as corrected by the City of St. Louis Division of Air Pollution Control. The 1972 emission data for the major sources in Illinois were provided by the Illinois Environmental Protection Agency.

Emissions from these major sources were projected for 1975, 1977 and 1980. This was done by assuming that the rate of increase in emissions for each major source was equal to the growth rate of the respective industry. Growth indices for the major point sources were obtained from OBERS (June 1970). These indices were used in projecting future emissions after taking into account reductions anticipated in the States' Implementation Plans.

No further reductions in HC and CO emissions were expected to be required for non-utility stationary sources in Missouri. Therefore, the 1975, 1977 and 1980 projected emissions for Missouri sources were calculated from the 1972 emissions and the appropriate industry growth rate with two exceptions. The City of St. Louis Division of Air Pollution Control indicated that emissions from the city's municipal incinerators will decrease 3.2 percent per year. The other exception was based on data provided by the Monsanto Industrial Chemicals Company, which indicated that the company would operate substantially under capacity in 1975. Consequently the estimated 1975 CO emissions for Monsanto-Queeny were based on this information; the 1977 and 1980 emissions were then projected based on the chemical industry growth rate while using 1975 as a base year.

For non-utility stationary sources in Illinois, the anticipated reductions by 1975 due to the Illinois EPA's regulations were 85 percent for HC and 82 percent for CO. Therefore, before calculating the projected emissions based on growth rates, the 1972 allowable emissions were calculated by reducing 1972 HC and CO emissions by 85 percent and 82 percent respectively. The 1975, 1977 and 1980 projected emissions were then calculated by applying the appropriate industry growth rate to the 1972 calculated allowable emissions.

Minor Non-Utility Stationary Sources. The NEDS point source printout for the St. Louis AQCR was used to determine the total emissions from all sources which emitted less than 100 tons per year in 1972. This was done by tabulating the emissions from each point source which contributed ten or more tons per year. These emissions were then totaled for all plants which individually emitted less than 100 tons per year. The result was the total emissions from all other (less than 100 short tons per year) non-utility stationary sources. Emissions from these sources for 1975, 1977 and 1980 were projected using the growth rate of miscellaneous manufacturing.

Because the baseline and projected emission inventories are used to estimate AQMA pollutant concentration levels, emission sources were gridded or spatially distributed within the urban-in-fact area. These gridding procedures are described below.

- Point Sources. Coordinates for all power plant and major non-utility point sources were available and were used to locate each source geographically.

- Non-Automotive Area Source Emissions. It was assumed that non-automotive area source emissions are at a constant level throughout each jurisdiction in the AQCR. Thus, each grid was assigned emissions according to grid area relative to the jurisdiction area. Total jurisdiction area was determined by summing all the grids.

- Automotive Emissions. Automotive emissions were calculated for each of the four jurisdictions in the gridded area. For this purpose, exhaust emission factors were calculated for each separate jurisdiction, based on the speed data found in the 1970 highway network study. Automotive emissions were distributed among the grids in proportion to the relative traffic densities of each grid as determined from the highway network study. Since this study did not include 100% of the traffic, it was used solely for proportioning purposes.

Air quality projections were developed from the emission forecasts. The APRAC-1A urban diffusion model was used to estimate reductions in maximum CO levels that would occur by implementing two proposed control strategies.

The APRAC-1A diffusion model for carbon monozide was developed by Stanford Research Institute to simulate CO concentrations that result primarily from multiple line sources distributed over an urban area. Diffusion calculations are made for sources that fall within angular sectors that extend upwind from each specified receptor point. Each cone-shaped area is divided into segments spaced at increasing intervals away from the receptor point. The segments, which are at different locations for each change in wind direction or receptor point, may be thought of as overlaying a fixed traffic network for the urban area.

For receptor points in the region for which 1972 CO sampling data were available, the ratios of concentrations predicted by the model for 1975/1977 and 1972 were used as the basis for proportional changes in the 1972 measured maximum levels. This procedure eliminated the effect of most of the sensitive inputs to the model, such as specification of most adverse meteorological conditions and description of the location of the receptor site relative to the nearest street, and made the changes in CO concentrations almost entirely dependent on differences in the traffic and emission rate input data. In effect, this procedure is similar to a proportioral reduction model in which the emissions are weighted according to their proximity to the receptor. At receptor sites where no measured air quality data were available, concentrations predicted by the diffusion model had to be used directly. Thus, these reported values are subject to much larger errors.

Expected ground level concentrations of non-methane hydrocarbons were calculated using the Gifford-Hanna model. This model assumes that the emissions from an urban area are represented by a uniform grid of area sources. A further assumption is made that the emission density of each grid is constant with time and that the grid-to-grid variability in emission densities is not large. The cross-wind component of diffusion is neglected and the vertical component is assumed to be Gaussian.

The area source emission density grid includes motor vehicle exhaust emissions and evaporative losses, evaporative losses from gasoline marketing and other area sources of hydrocarbon emissions. In addition there are 28 point sources for which 1972 hydrocarbon emissions exceeded 100 tons per year. The emissions from these point sources are treated as area sources in this application of the Gifford-Hanna technique.

4. THE TRIAL AIR QUALITY MAINTENANCE PLAN (AQMP)

The goal of the Trial AQMP study was two-fold: the development of a preliminary Air Quality Maintenance Plan and a critique of the EPA guidelines for the preparation of Air Quality Maintenance Plans. Because the project was a demonstration exercise and did not result in an official AQMP, and because time and resources were restricted, it was necessary to make certain compromises in data collection and

analysis. Three steps were involved in developing the trial AQMP:

- Perform a detailed analysis of existing and projected emissions and air quality
- Select and evaluate an air quality maintenance strategy
- Determine the jurisdictional cooperation and coordination necessary to implement the AQMP.

The present analysis considers the first step, the estimation of existing and projected emissions and air quality. This effort included projecting emissions and air quality for TSP, SO_x, HC, and CO for the St. Louis AQMA (a subregion of the St. Louis AQCR) for the years 1980 and 1985. The following narrative describes the projection methodology in more detail.

Existing inventory data in the St. Louis Air Quality Maintenance Area were found to vary both in the year-of-record for a particular source type and in completeness of information. To overcome the variation in year-of-record, existing inventories were projected to 1975 for each pollutant. This procedure aligns all emissions data to a baseline year and assumes that all sources will be in compliance with existing emission control regulations by 1975. To eliminate discontinuities in information, existing information was supplemented by special analyses to provide complete baseline emission data.

The information used in the development of the baseline emission inventory was extracted from the following sources:

- State Implementation Plans of Illinois and Missouri
- NEDS
- Local transportation studies, utility statistics and related data
- The Attainment Study
- Bureau of Economic Analysis statistics.

The special analyses undertaken were:

- Emissions from primary point sources after compliance to existing regulations
- Point and area source spatial distribution (for TSP and SO_x only)
- Subcorridor-VMT emission analysis (for CO and HC only).*

Once the complete data baseline was established, emissions were projected for four source categories: point sources (except power plants), power plants, stationary area sources and mobile sources. The specific sources consulted for base year emission data, and the projection methodology applied to each source category is discussed in the following sections.

(1) Point Sources (Except Power Plants)

Point source emissions data were broken down into primary sources (greater than 100 tons per year) and non-primary sources for each pollutant. For the primary point sources for TSP and SO_x, summaries of source emissions at compliance, prepared by the Illinois Environmental Protection Agency and the Missouri Air Conservation Commission, were used. For the non-primary source emissions, the emissions were assumed to be uncontrolled (except as stated in the SIP) and were taken from NEDS. The CO and HC 1975 point source emissions were taken from the Attainment Study (as corrected by Illinois EPA).

The preferred method for projecting point source emissions for 1980 and 1985 was to obtain growth rates for each company, power plant, and institution that represents a primary point source. The OBERS projections were used for non-primary point sources and in cases where actual growth rates could not be obtained for a primary point source. Accordingly, a survey was conducted of the primary point sources to gather

* This study was an analysis of transportation plans and related data concerning the traffic corridors, subcorridors and highway links in the metropolitan area, in order to develop projections of highway vehicle emissions.

information on growth rates, productivity increase estimates, and expected increases in capacity. Responses were received from approximately 35 percent of the sources contacted. Once the baseline point source inventory and the growth factors for all the sources were developed, the 1980 and 1985 emissions were generated by multiplying the baseline emissions by the annually compounded growth factors.

(2) Power Plants

Individual plant data were provided by Union Electric Company, Illinois Power Company, Missouri Air Conservation Commission, and the Illinois Environmental Protection Agency. Compliance schedules, control equipment, stack emissions, and growth factors were applied by MACC and IEPA to the power plants data to generate an inventory of controlled emissions in 1975. To project power plant emissions for 1980 and 1985, the growth factors and the scheduled changes in new and old plants were applied to 1975 baseline controlled emissions.

(3) Stationary Area Sources

Area source emissions data for 1970, 1972, and 1974 were gathered and projected to 1975 by applying the percent emission control as required by the State Implementation Plan and growth factors for each area source.

The method used for projecting area source emissions for 1980 and 1985 was to obtain growth rates from OBERS growth statistics and local estimates. Projections were generated by individual area source category (residential, industrial, and commercial) and summarized to give total area source emissions for each pollutant.

(4) Mobile Sources

Mobile source emissions were divided into two categories: highway and off-highway vehicles. Highway vehicles include both light- and heavy-duty vehicles; off-highway vehicles include railroads, vessels, aircraft, and other vehicles not operated on roads.

For off-highway vehicles, mobile source emissions data were gathered from NEDS and the Missouri and Illinois State Implementation Plans. Off-highway emissions were projected using a three percent average growth rate, which parallels the national average. This growth rate was applied to the four pollutants.

For highway vehicles, mobile source emissions data were obtained from the Attainment Study for the baseline year of 1975. Highway emissions for TSP and SO_x were projected by applying TSP and SO_x emissions factors to projected annual vehicle miles of travel (VMT). Highway emissions for CO and HC for 1980 were taken from the Attainment Study for the Air Quality Control Region and extrapolated to reflect the Air Quality Maintenance Area. The projected 1985 emissions were calculated from the special analysis (Subcorridor VMT Emissions Analysis) for the St. Louis urban-in-fact area by interpolating the 1970 and 1995 traffic network data for each subcorridor and link type and extrapolating to reflect the entire Air Quality Maintenance Area. The distribution of VMT and emissions by subcorridor and link type was calculated in this analysis.

Projections of air quality for 1975, 1980, and 1985 were developed for the St. Louis AQMA based on projected emission levels. The techniques used to model air quality varied for each of the four pollutants considered, so each pollutant is discussed separately.

- Total Suspended Particulates. The projection of annual concentrations for TSP was accomplished through application of statistical relationships between TSP emissions density and concentration.* The relationship may be expressed as a curve (where 1964 TSP concentration samples are plotted against emissions densities for various land areas larger than 20 square miles).

  The projection method required the summary of emissions from all sources within selected subareas (36 square miles or greater) of the St. Louis AQMA and the determination of emission

* U.S. Department of Health, Education, and Welfare, Interstate Air Pollution Study: Phase II Project Report, December 1966.

density values by division of total emissions for each subarea by area size. Estimated annual concentration were then found from the curve and recorded at the center of each selected subarea in the AQMA. Isopleths were drawn, based on concentrations at subarea centers, which display the mean annual TSP concentration distribution in the St. Louis AQMA. Background concentration was estimated at 40 micrograms per cubic meter.

. Sulfur Dioxide. The projection of air quality concentrations for SO_2 was accomplished by applying two air quality diffusion models: Miller-Holzworth for the St. Louis central urban area and the Wood River refinery complex, and Pasquill-Gifford plume dispersion for four significant point sources.

These two projection methods required calculation of concentrations from given equations. The Miller-Holzworth equation calculates annual average areawide concentrations of SO_2 from emissions density, mixing depth, urban size, and mean annual wind speed. The Pasquill-Gifford plume dispersion calculates a maximum 24-hour average concentration of SO_2 from wind speed, plume rise, emissions rate, stack parameters, meteorological stability, and assumes a Gaussian plume.

. Carbon Monoxide. The APRAC-1A Diffusion Model was used to project carbon monoxide concentrations from projected emissions. Estimates of 8-hour CO concentrations were calculated for 1975 at nine selected receptor sites. CO concentrations in 1980 and 1985 at these receptors were extrapolated from the 1975 estimates using the following procedure:

- Assume worst case meteorological conditions do not vary

- Assume concentrations of CO are directly proportional to emissions of CO under constant worst-case meteorological conditions

- Calculate 1975, 1980, and 1985 CO emissions in the vicinity of the selected nine receptors using the subcorridor VMT analysis

- Calculate the change in emissions in the vicinity of each receptor from 1975 to 1980, and 1980 to 1985.

- Apply the corresponding percent change in emissions to the 1975 concentration at each receptor to obtain 1980 and 1985 concentrations.

This procedure is equivalent to a "roll-forward" type of calculation using the results of calibrated diffusion model to represent baseline air quality.

. Photochemical Oxidants. A statistical relationship between percent reduction in hydrocarbon emissions and maximum one-hour photochemical oxidant concentrations was published in the Federal Register.* This relationship was used to convert the emission projections to expected maximum oxidant concentrations.

The EPA has defined oxidants as an areawide problem. Consequently projected emissions from the entire AQMA were used to determine the percent emission reductions from the air quality baseline year of 1972 to 1975, 1980 and 1985. The 1972 second highest 1-hour concentration was used as the baseline for oxidants.

* * * * *

Figure 2 contains a summary of all four emission projection methodologies. For each general emission source category (power plants, other point sources, highway

* Federal Register 40CFR51, Regulations on Preparation of Implementation Plans, Appendix J.

vehicles and other area sources), the data sources consulted for

- Base year emissions
- Growth forecasts
- Applicable emission control regulations

are given for each projection methodology. For a complete description of a given methodology, consult the references cited previously in the summary of that methodology.

FIGURE 1
Summary of Emission Projection Methodologies*

Emission Source Category	PROJECTION METHODOLOGY			
	REPS	PRMS	Attainment Study	Trial AQMP
POINT SOURCES (POWER PLANTS)				
• Base year emissions	NEDS	NEDS	NEDS	NEDS Local
• Growth	FPC	FPC	Utility-supplied and OBERS	FPC
• Pollution abatement	NEDS (allowable emissions) and Federal regulations	SIP, compliance by 1977 and NEDS (allowable emissions)	None	Local air pollution agencies
POINT SOURCES (EXC POWER PLANTS)				
• Base year emissions	NEDS	NEDS	NEDS, as corrected by local air pollution agencies	Major - local air pollution agencies Minor - NEDS
• Growth	OBERS/SEAS (industry-specific growth applied to individual sources)	OBERS (industry-aggregated growth applied to individual sources)	OBERS (industry-specific growth applied to plant emissions)	Plant survey and OBERS (industry- and plant-specific growth applied to plant emissions)
• Pollution abatement	NEDS (allowable emissions) and Federal regulations	SIP, compliance by 1977 and NEDS (allowable emissions)	Local air pollution agencies	SIP, compliance by 1975 (major sources)
HIGHWAY VEHICLES				
• Base year emissions	NEDS	NEDS	Local traffic data	Local traffic data
• Growth	OBERS	FMVCP (includes growth)	Local transportation studies	Local transportation studies
• Pollution abatement	Weighted emission factors (AP-42 method revised)	FMVCP (includes change in emission factors)	Weighted emission factors (AP-42 method)	Weighted emission factors (AP-42 method)
AREA SOURCES (EXC HIGHWAY VEHICLES)				
• Base year emissions	NEDS	NEDS	NEDS	NEDS and SIP
• Growth	OBERS	OBERS and local growth data	OBERS and local growth data	OBERS and local growth data
• Pollution abatement	None	Local regulations, compliance by 1975	None	SIP, compliance by 1975

*See text for complete description and definition of terminology.

III. COMPARISON AND INTERPRETATION OF NUMERICAL PROJECTION RESULTS

1. NUMERICAL COMPARISON OF PROJECTION DATA

The numerical projection results for REPS, the Trial AQMP and the Attainment Study are presented in Tables 1-3 respectively. Emission projections are given for:

- Power plants
- Other point sources (excluding power plants)
- Highway vehicles (excluding diesel vehicles for REPS and the Attainment Study, including diesel vehicles for the Trial AQMP)
- Other area sources (excluding highway vehicles).

For the Trial AQMP and the Attainment Study, these categories are consistent with the format and level of detail for which emission projection data were published in the cited references. The output of REPS was given in the NEDS National Emission Report (NER) format, which provides substantially more source category detail than is shown in Table 1. The REPS data were aggregated to that format to facilitate the comparison.

The PRMS output projections are given in a different source category format:

- Fuel combustion
- Industrial process
- Solid waste
- Transportation
- Miscellaneous.

These data are given in Table 4. In order to facilitate numerical comparisons with the other methodologies, the PRMS data for 1975 were reorganized into comparable source categories. This was done by using 1972 NEDS inventory data to disaggregate the emissions of the PRMS categories; these data were then reaggregated into the categories used by the other methodologies. The redistributed PRMS data were given in Table 5.

Table 1
Emission Projections: REPS
(Tons per year)

Source Category	1975	1980
	Total Suspended Particulates	
Power Plants	48,884	12,186
Other Point Sources	64,554	29,708
Highway Vehicles	8,372	7,200
Other Area Sources	31,838	38,341
Total	153,648	87,435
	Sulfur Dioxide	
Power Plants	1,026,000	611,504
Other Point Sources	1,289,813	201,694
Highway Vehicles	3,360	2,201
Other Area Sources	41,792	50,418
Total	1,289,813	865,823
	Carbon Monoxide	
Power Plants	6,540	6,380
Other Point Sources	161,533	150,410
Highway Vehicles	663,459	383,259
Other Area Sources	69,172	72,411
Total	900,704	612,460
	Hydrocarbons	
Power Plants	2,182	1,860
Other Point Sources	79,747	81,447
Highway Vehicles	112,544	39,563
Other Area Sources	46,407	49,207
Total	240,880	172,077

NOTES: "Other point sources" are all point sources except power plants
"Highway vehicles" include gasoline and diesel highway vehicles
"Other area sources" are all area sources except gasoline and diesel highway vehicles.

Table 2

Emission Projections: Trial AQMP

(Tons per Year)

Source Category	1975	1980	1985
Total Suspended Particulates			
Power Plants	20,348	34,064	34,863
Other Point Sources	50,329	57,972	71,617
Highway Vehicles	8,383	9,622	10,823
Other Area Sources	22,602	24,632	28,465
Total	101,662	126,290	145,768
Sulfur Dioxide			
Power Plants	577,190	864,748	873,000
Other Point Sources	194,046	204,013	218,452
Highway Vehicles	2,065	2,371	2,666
Other Area Sources	43,779	48,712	54,935
Total	797,080	1,119,844	1,149,053
Carbon Monoxide			
Power Plants	1,641	1,641	1,700
Other Point Sources	46,821	50,870	59,734
Highway Vehicles	476,242	241,459	146,070
Other Area Sources	60,699	64,537	70,658
Total	585,403	358,507	278,162
Hydrocarbons			
Power Plants	1,191	1,395	1,666
Other Point Sources	40,208	50,330	55,009
Highway Vehicles	82,502	39,217	25,956
Other Area Sources	41,606	45,157	50,446
Total	165,507	136,009	133,085

NOTES: "Other point sources" are all point sources except power plants

"Highway vehicles" include gasoline and diesel highway vehicles

"Other area sources" are all area sources except gasoline and diesel highway vehicles.

Table 3
Emission Projections: The Attainment Study
(Tons per Year)

Source Category	1972	1975	1977	1980
		Carbon Monoxide		
Power Plants	7,238	9,240	10,824	13,838
Other Point Sources	102,300	42,240	44,660	48,290
Highway Vehicles	632,610	502,260	386,430	254,650
Other Area Sources	83,930	87,010	89,320	92,840
Total	826,100	641,300	531,300	409,200
		Hydrocarbons		
Power Plants	3,278	4,224	4,829	6,204
Other Point Sources	53,460	38,390	41,800	46,860
Highway Vehicles	113,410	87,010	60,720	41,360
Other Area Sources	43,890	45,540	46,640	48,400
Total	214,500	174,900	154,000	143,000

NOTES: "Other point sources" are all point sources except power plants
"Highway vehicles" include only gasoline vehicles
"Other area sources" are all area sources except gasoline highway vehicles.

Table 4
Emission Projections: PRMS
(1000 Tons per Year)

Source Category	1972	1975	1977
	Total Suspended Particulates		
Fuel Combustion	95	90	90
Process and Incineration	34	28	28
Transportation	10	10	10
Other*	-	-	-
Total	139	128	128
	Sulfur Dioxide		
Fuel Combustion	575	400	400
Process and Incineration	120	70	70
Transportation	10	10	10
Other*	-	-	-
Total	705	480	480
	Carbon Monoxide		
Fuel Combustion	20	20	20
Process and Incineration	230	90	90
Transportation	960	820	680
Other*	-	-	-
Total	1,210	930	790
	Hydrocarbons		
Fuel Combustion	15	15	15
Process and Incineration	60	60	60
Transportation	190	175	145
Other*	55	42	50
Total	320	292	270

* Primarily area sources.

Table 5
Emission Projections: PRMS
(Modified Source Category Format)
(1000 Tons per Year)

Source Category	1972	1975	1977
Total Suspended Particulates			
Power Plants	50	48	48
Other Point Sources	53	46	46
Highway Vehicles	6	6	6
Other Area Sources	30	28	28
Total	139	128	128
Sulfur Dioxide			
Power Plants	517	360	360
Other Point Sources	155	94	94
Highway Vehicles	5	5	5
Other Area Sources	28	21	21
Total	705	480	480
Carbon Monoxide			
Power Plants	8	8	8
Other Point Sources	231	91	91
Highway Vehicles	922	787	653
Other Area Sources	49	44	38
Total	1,210	930	790
Hydrocarbons			
Power Plants	3	3	3
Other Point Sources	63	63	63
Highway Vehicles	167	154	128
Other Area Sources	87	72	76
Total	320	292	270

Total emissions as a function of time, as projected by the four methodologies, are illustrated in Figure 3-6. These four figures give the projections for TSP, SO_x, HC and CO respectively. Numerical comparison of air quality projections was not attempted because only the Trial AQMP and the Attainment Study addressed air quality projections, and the Attainment Study considered only two pollutants.

It can be seen from Figures 3-6 that the emission projection curves for TSP and SO_x resemble each other and the curves for HC and CO resemble each other. The TSP and SO_x emission projections are similar because for both pollutants:

- The major sources are stationary industrial point sources
- Future emissions are determined by the rate of compliance of stationary sources to emission standards and their expected growth
- Each methodology applied similar forecasting techniques to TSP and SO_x emissions.

The HC and CO emission projections resemble each other because for both pollutants:

- The major source is highway vehicles (specifically gasoline vehicles)
- Future emissions are determined by the rate at which late-model vehicles, equipped with more stringent control devices, gradually replace older vehicles, and expected changes in vehicle travel characteristics
- Each methodology applied similar forecasting techniques to HC and CO emissions.

Consequently, in the following discussion the numerical results of the TSP and SO_x projections will be discussed concurrently, followed by a concurrent discussion of the HC and CO projections.

2. ANALYSIS OF TSP AND SO_x EMISSIONS

A valid comparison of numerical projection results may be done only for the same period in time. The base year for both REPS and the Trial AQMP is 1975. The PRMS study preceded these, starting in 1970; 1975 is PRMS

FIGURE 3
TSP Projections

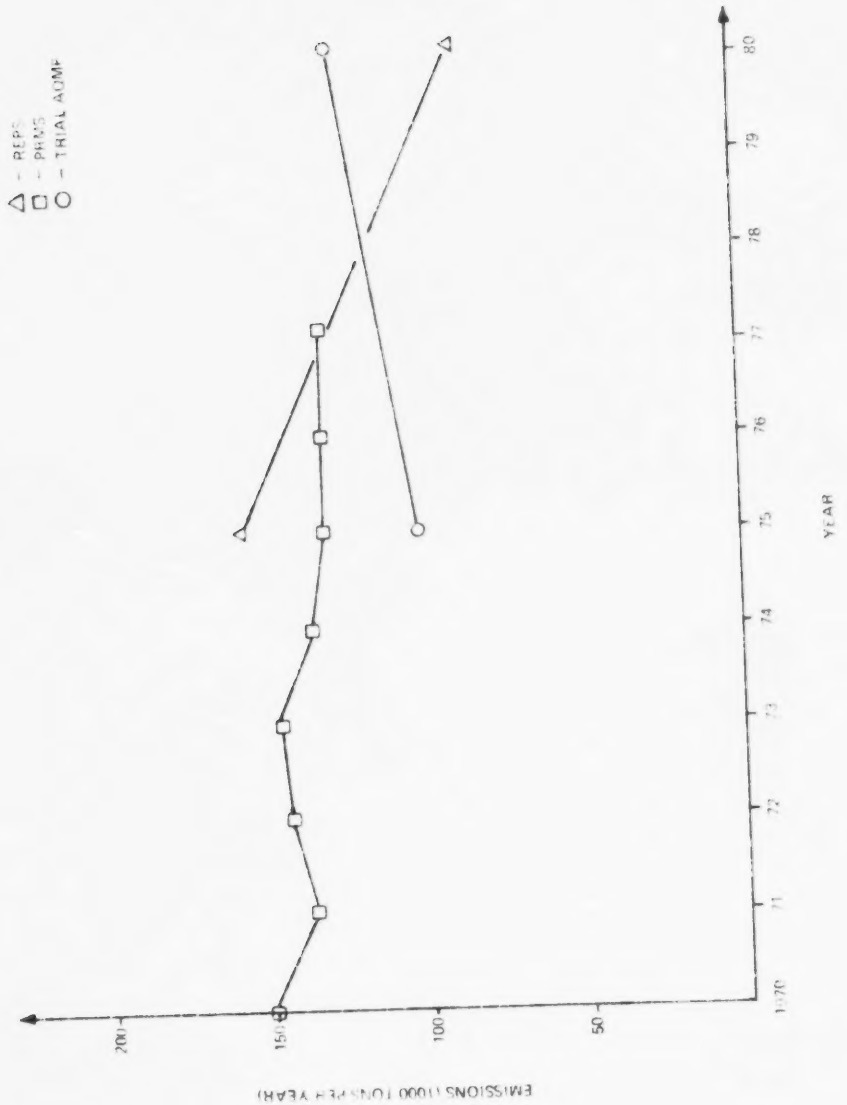


FIGURE 4
SOX Projections

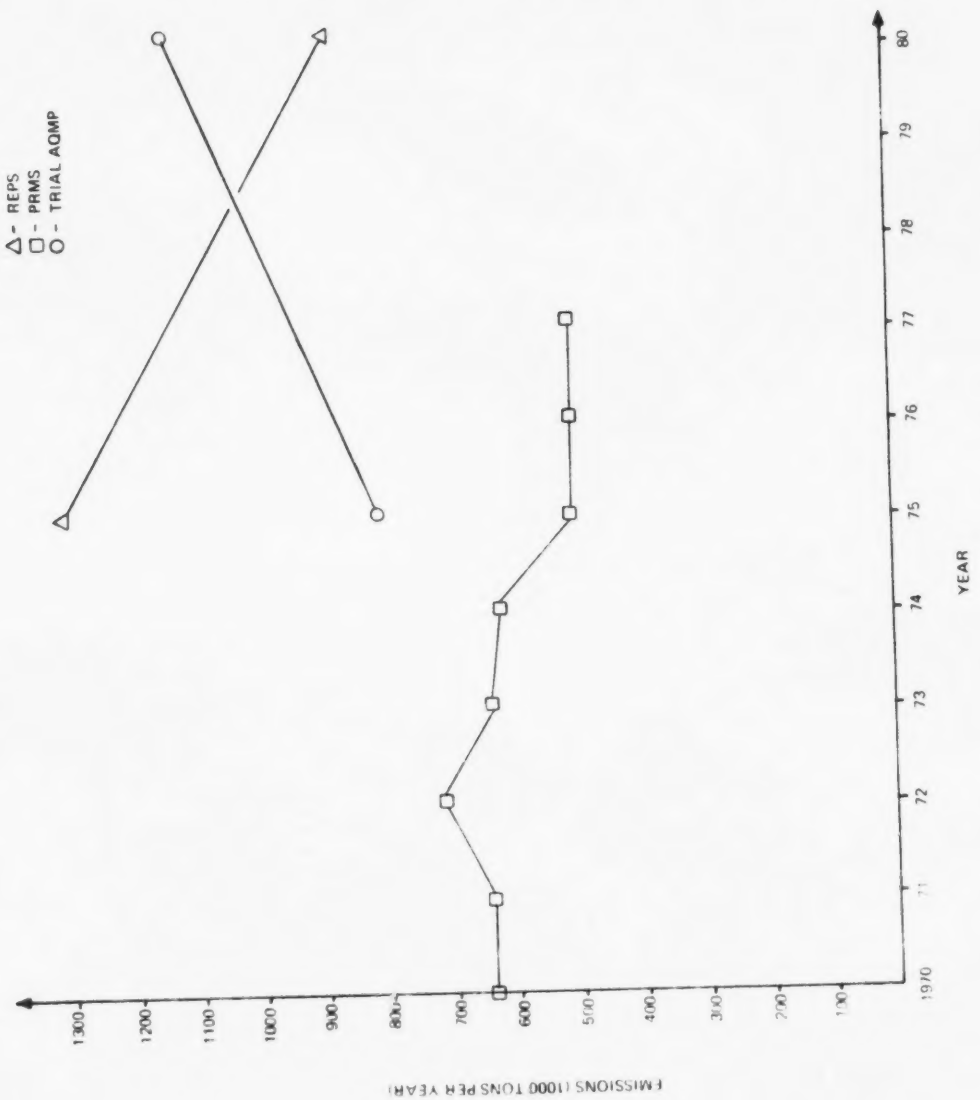


FIGURE 5
HC Projections

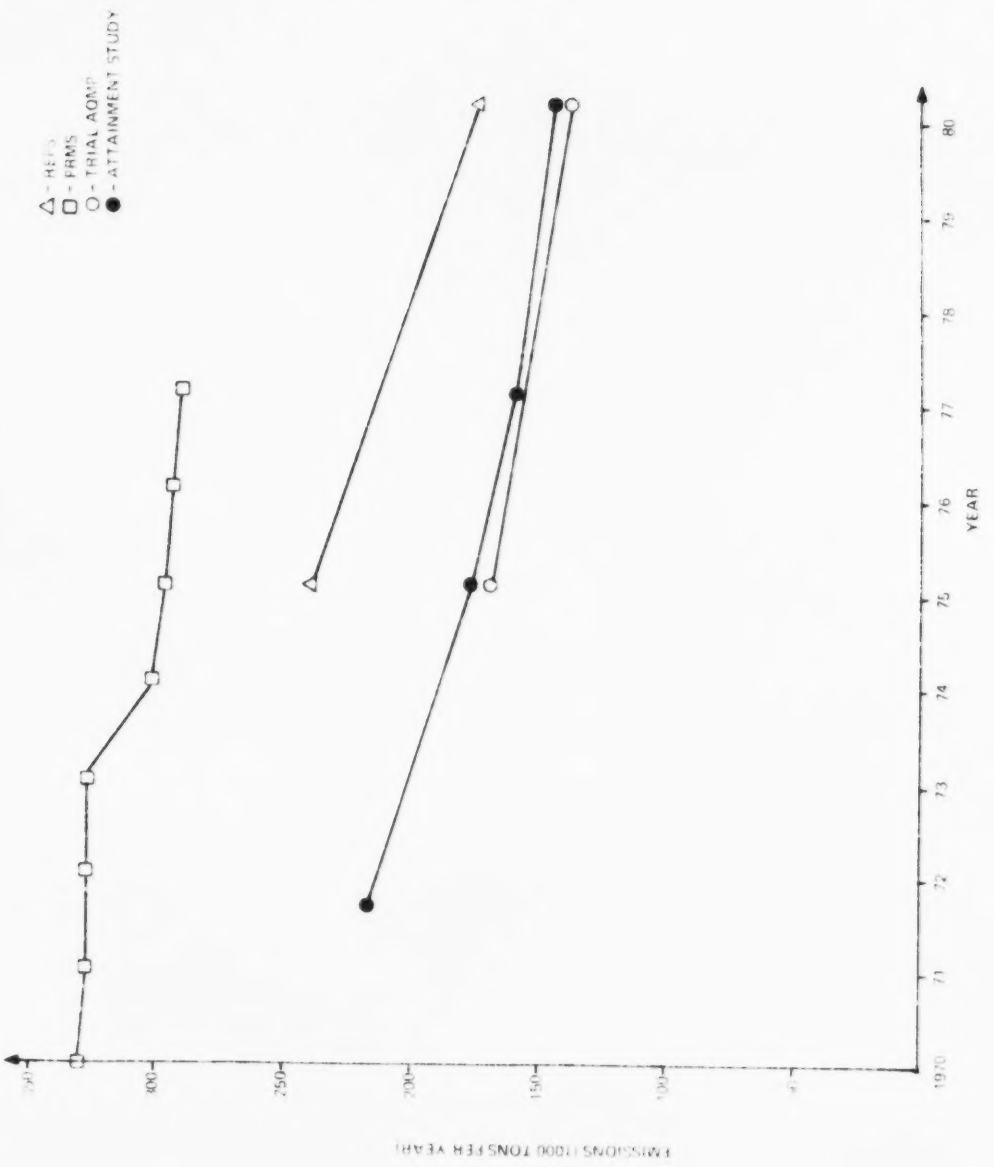
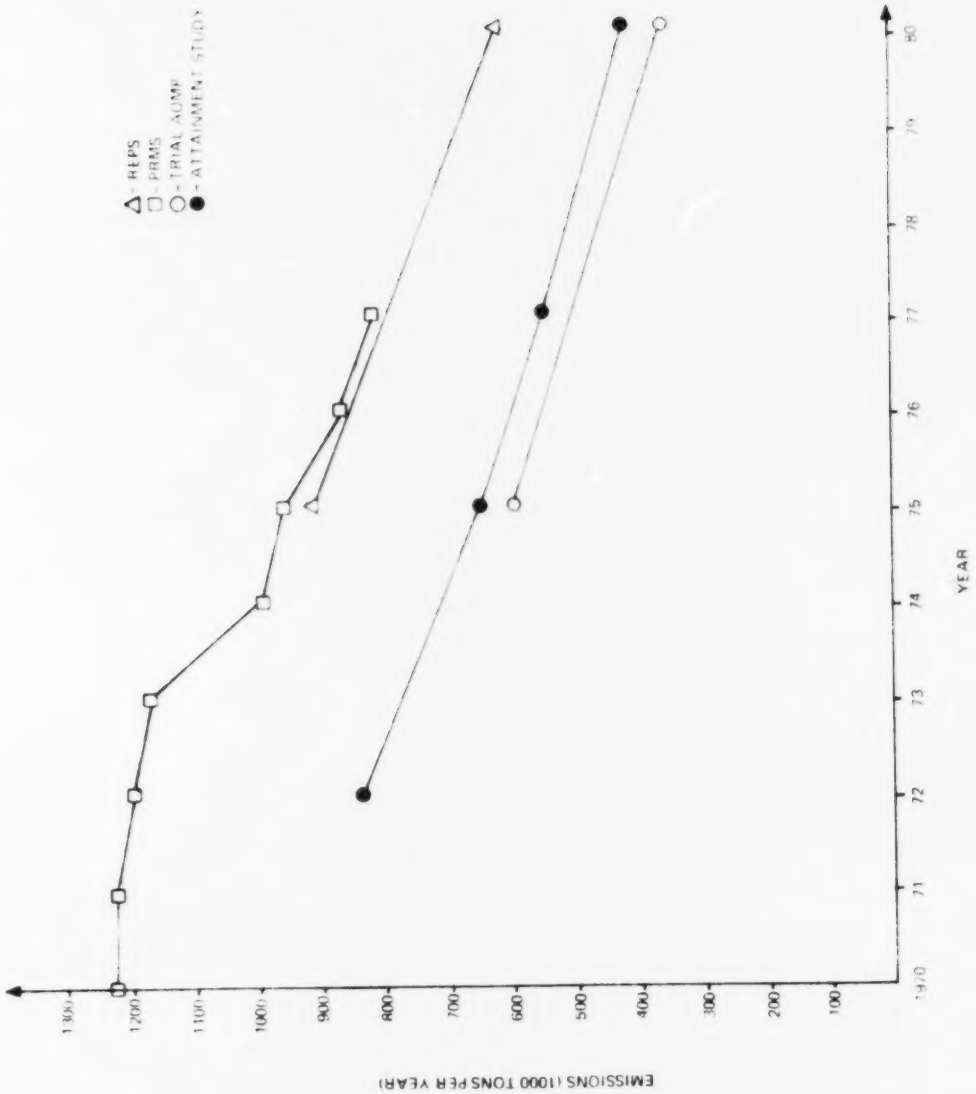


FIGURE 6
CO Projections



projection year. This makes a direct comparison involving PRMS difficult because emission inventories, growth estimates and abatement regulations (especially for point sources) evolved significantly during that period. In addition, in the PRMS study it was assumed that emissions would remain constant between 1975 and 1977 because the necessary stationary source regulations would be promulgated and enforced. Consequently, the comparison, while including PRMS to some extent, focuses on the other two methodologies.

The key characteristics of Figure 3 and 4 are that between 1975 and 1980:

- REPS forecasts a net decrease for both pollutants
- The Trial AQMP forecasts a net increase for both pollutants
- The REPS projections are higher than those of the Trial AQMP in 1975 but lower by 1980 (the curves intersect).

These differences are attributable primarily to variation in year of record of the baseline emission inventory, and assumptions concerning the timing of compliance of stationary sources to emission regulations. These considerations are discussed in more detail below.

Emissions for 1975 by source category, as given in Tabels 1, 2 and 5, are as follows:

1975 TSP Emissions, 1000 TPY

Source	REPS	Trial AQMP	PRMS
Power Plants	49	20	48
Other Point Sources	65	50	46
Total (Point Sources)	114	71	94
Highway Vehicles	8	8	10
Other Area	32	23	24
Total Emissions	154	102	128

1975 SO_x Emissions, 1000 TPY

Source	REPS	Trial AQMP	PRMS
Power Plants	1026	865	360
Other Point Sources	219	204	94
Total (Point Sources	1245	1069	454
Highway Vehicles	3	2	10
Other Area	42	49	16
Total Emissions	1290	1120	480

Total 1975 TSP and SO_x emissions are highest for REPS. PRMS emissions are about the same or lower than REPS for all source categories. Since REPS used the NEDS inventory as of early 1975 for a baseline inventory, the NEDS inventory from which PRMS baseline emissions were taken in 1970 has been enlarged substantially since 1970. This discrepancy is more significant for SO_x emissions, where the point source PRMS emissions are less than half those of REPS.

The Trial AQMP emissions are also less than REPS for both TSP and SO_x. The largest emission categories are power plant and other point sources. The 1975 point source inventory was estimated in the Trial AQMP by projecting the emission inventory to 1975 from previous years and assuming that all sources would comply with SIP regulations by 1975. Since the REPS projections indicate that many sources were not in compliance by early 1975, the Trial AQMP, by assuming compliance, probably underestimated the actual 1975 emission inventory.

In addition, large point sources may be located outside the AQMA but inside the AQCR (the Trial AQMP considered the AQMA, which is smaller than the AQCR). It could not be determined from the available data whether this in fact is the case.

There is a marked difference in the trend of TSP emissions as projected by REPS (decreasing emissions) and the Trial AQMP (increasing emissions):

TSP Emissions* (1000 TPY)

Source	REPS		Trial AQMP	
	1975	1980	1975	1980
Power Plants	49	12	20	34
Other Point Sources	65	30	50	58
Highway Vehicles	8	7	8	10
Other Area Sources	32	38	23	25
	154	87	102	126

NOTE: Totals may differ due to rounding.

Emissions from mobile and other area sources, as reported by both systems, do not change substantially, although the absolute levels are slightly different. Point source emissions do change, however; the Trial AQMP forecasts moderate increases, while REPS forecasts significant decreases. The REPS decreases occur because the emission abatement required by the point source specific compliance schedules in the current NEDS file for the 1975-1980 period more than offsets projected growth in activity. On the other hand, the Trial AQMP did not expect any additional stationary source abatement during that period, so emissions increase because of projected industrial growth.

3. ANALYSIS OF HC AND CO EMISSIONS

Estimates of 1975 and 1980 highway vehicle emissions were developed for the AQCR in the Attainment Study; the Trial AQMP used these estimates directly after adjusting the data to reflect the AQMA boundaries. This is evident from Figures 5 and 6 in which HC and CO vehicle emissions forecast by the Trial AQMP are almost uniformly 5 percent less than those of the Attainment Study. This is consistent with the fact that in 1972 the AQMA recorded 4.8 percent fewer VMT than the AQCR. Consequently the Trial AQMP data are not included in the comparison.

* From Tables 1 and 2.

The most distinguishing characteristic of Figures 5 and 6 is that all the emission projection curves for both HC and CO decrease with time with roughly the same slope. This indicates that all the methodologies account for more stringent vehicle emission controls in an equivalent manner. The vertical separation between curves indicates that base year vehicle travel characteristics (VMT and average speed) were not identical. The reasons for this are discussed below.

Emissions for 1975 by source category as given in Tabels 1, 3 and 5 are as follows:

1975 HC Emissions* (1000 TPY)

Source	REPS	Attainment Study	PRMS
Power Plants	2	4	3
Other Point Sources	80	38	63
Total (Point Sources)	82	42	66
Highway Vehicles	113	87	154
Other Area Sources	46	46	72
Total (Area Sources)	159	133	226
Total Emissions	241	175	292

1975 CO Emissions* (1000 TPY)

Source	REPS	Attainment Study	PRMS
Power Plants	7	9	8
Other Point Sources	162	42	91
Highway Vehicles	663	502	787
Other Area Sources	69	87	44
Total Emissions	901	641	930

* Totals may differ due to rounding.

The two most important source categories for HC emissions are highway vehicles and (to a lesser extent) non-utility point sources. PRMS reports the highest 1975 HC emissions because of a comparatively high estimate for vehicle emissions; non-utility point source emissions for PRMS are actually lower than REPS. In the PRMS system, 1970 emissions for highway vehicles were taken from NEDS, and net emissions were calculated using the Federal Motor Vehicle Control Program (FMVCP) data.* The use of this approach, which is relatively simple when compared to the more sophisticated methods used by the other projection systems, may have caused the higher emission estimates.

REPS reported higher HC emissions than the Attainment Study in 1975, for both non-utility sources and highway vehicles. The non-utility point source emissions may be higher for the same reasons that TSP and SO_x emissions for REPS were also higher than those of the Attainment Study: there may be large point sources outside the AQMA but within the AQCR, and full SIP compliance by 1975 is postulated.

For all the studies, 1975 highway emissions are a function of VMT, average speed and weighted emission factors; the latter are computed from vehicle age and model year distributions and deterioration of control devices. Average speed and VMT for the Attainment Study were taken from a 1972 highway network study and projected to 1975; these data may not have been incorporated into the NEDS inventory used by REPS. Weighted emission factors used by the Attainment Study used local vehicle distributions while REPS used national distributions. These factors would be sufficient to account for the differences in 1975 highway emissions.

HC and CO emissions are expected to decrease during the period 1975-1980 according to both REPS and the Attainment Study:

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* In the PRMS method, expected emissions are forecast as a simple fraction of 1970 emissions; FMVCP data are used to compute these fractions which include the effects of expected growth and weighted automobile emission factors reflecting relaxed 1975 standards.

HC Emissions* (1000 TPY)

	REPS		Attainment Study	
Source	1975	1980	1975	1980
Power Plants	2	2	4	6
Other Point Sources	80	81	38	47
Highway Vehicles	113	40	87	41
Other Area Sources	46	49	46	48
Total	241	172	175	143

CO Emissions* (1000 TPY)

	REPS		Attainment Study	
Source	1975	1980	1975	1980
Power Plants	7	6	9	14
Other Point Sources	162	150	42	48
Highway Vehicles	663	383	502	255
Other Area Sources	69	72	87	93
Total	901	612	641	409

These decreases are caused by decreased highway vehicle emissions, since all the other source categories remain relatively unchanged. The rate of decrease for both HC and CO emissions is about the same for both systems; slight differences may be the result of different forecasts of:

- The weighted emission factors appropriate for projection years
- Travel characteristics (VMT and average speed).

* Totals may differ due to rounding.

While both REPS and the Attainment Study calculate emission factors for projection years using AP-42 data, REPS uses parameters which were updated after publication of the Attainment Study. On the other hand, the travel forecasts of the Attainment Study are based on county-specific growth factors derived from two local transportation studies, while the REPS travel forecasts are based on population projections. These differences could easily account for the slight differences in projected emissions.

4. CONCLUSIONS

The summary and comparison of projection methodologies applied to St. Louis has identified a number of considerations which are important for projecting emissions for any geographic area. First of all, future emissions ordinarily are forecast based on these three types of data:

- Base year emissions (stationary sources) and transportation activity (mobile sources). Emission projections are only as accurate as the inventories on which they are based. Care should be taken that the inventories are up-to-date and include all major sources. "Unconventional" sources like fugitive dust which in the past were often ignored, are in many areas significant pollution sources.

- Estimates of industrial, demographic and transportation growth. In addition to forecasting growth for existing sources, new sources entering or leaving the region must be identified.

- Emission abatement regulations and compliance to these regulations. In St. Louis, as in many other regions, the effect of point source emission abatement regulations more than offsets expected growth.

Each of the methodologies reviewed had certain advantages and disadvantages. The following capabilities, which are important for any projection methodology, were inherent in at least one of the methodologies under study:

- Stationary source emissions should be estimated on an individual point source basis. This is critical because individual sources often have unique emission rates and compliance schedules.

Emission projections in REPS and PRMS are developed on an individual source basis, while in the Attainment Study and the Trial AQMP, emissions are forecast on a plant basis. For the latter approach plant-wide averages for growth and extent of control must be estimated for the various process and fuel combustion point sources within each plant.

- A computerized methodology greatly facilitates individual source calculations, and allows alternative forecast scenarios to be evaluated quickly and efficiently. REPS is a computerized model; in addition to containing complete "default scenario" data, REPS has extensive capability for override of these default data with more accurate local information concerning emission rates, growth and compliance schedules for existing and proposed stationary sources.

- All point and area sources must be identified by legislative jurisdiction. Computerized systems should be able to access all source data for each jurisdiction, in order to apply emission regulations for each jurisdiction to the appropriate sources. PRMS, the Attainment Study and the Trial AQMP considered all emission sources by jurisdiction. Although only NEDS information and Federal New Source Performance Standards were input to the REPS projections presented in this report, the effect of other local emission control regulations may be input to REPS by the system user.

- Local information and studies, such as plant survey data and detailed transportation studies, increase the accuracy of emissions (and air quality) forecasts. Plant surveys identify specific growth and expansion plans, compliance schedules and process changes. Transportation studies and forecasts define average speed, mileage and other traffic characteristics which have a significant effect on emission and air quality estimates. Both the Attainment Study and the Trial AQMP utilized plant surveys and detailed transportation forecasts.